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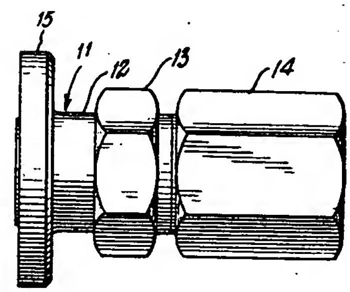


Fig. 1.

Fig. 2.

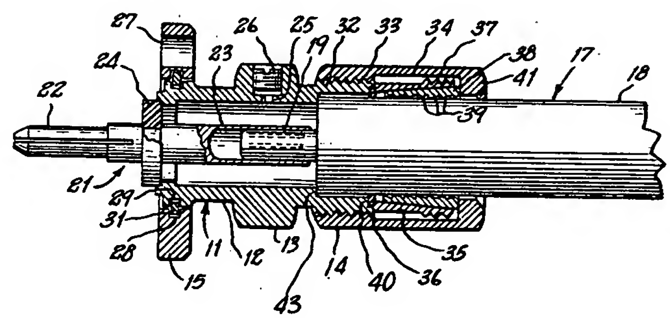
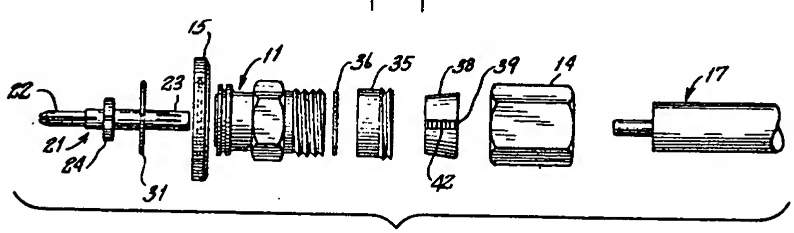


Fig. 3.



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47, 500/59.

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PATENT SPECIFICATION

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Classification 74. 5; 04. 2; 03. 2.

International Classification F 06 l; H 02 g.

Drawing attached.

COMPLETE SPECIFICATION.

"CONNECTOR FOR RODS OR TUBES."

The following statement is a full description of this invention, including the best method of performing it known to us.

The present invention relates to connectors for rods or tubes and more particularly to connectors which are adapted to grip unthreaded rods or tubes with a high degree of gripping strength and with a minimum of scoring or deformation of the rod or tube gripped. The present invention is adapted for use where either a high tensile strength connector, a fluid type connector, an electrical connector or a combination of the above is desired.

It is contemplated that the present invention will be particularly useful for connecting rods or bars of relatively soft material, such as plastic, or relatively soft metals, such as copper or aluminum. However, the use of the connector is not restricted to these applications, and it may be used, for example, for the connection of steel rods and steel or iron pipe as well.

The connection of rods and tubes provides numerous problems. Ideally the connection of rods and tubes should be accomplished with a minimum of time and with as few tools as possible, and particularly without requiring special tools. On the other hand a connector should be fluid-tight where it is desired to connect fluid conduits, and in all cases should be virtually as strong as the tubes or rods which it connects. A great variety of connectors are in use which utilize flare type connecting elements, soldered connecting elements, threaded connecting elements, aswaged reduction joint, or the like. Of the many

connecting means in use, few, if any, approach the ideal characteristics suggested above. In each case the connection requires special tools or an unduly long time to make the connection, or provides a connection of relatively low strength.

The present invention provides a connector assembly which upon rotation of one of its parts secures itself to a tube or rod forcing a number of cutting edges into the wall or the tube or rod which provides a connection comparable in tensile strength to the original strength of rod or tube members being connected.

The connector assembly according to the invention provides for a pre-assembled connection between a cylindrical member with a connector body in immediate contact thereof. Said connector body has a hollow externally threaded end portion and a cap nut having a threaded part screwable thereon, the cap part of said nut having an aperture permitting free movement there through of the cylindrical member. An internally tapered ring is provided within an enlarged internal portion of the cap, between the cap part and the threaded part, the smallest internal diameter of the ring being slightly larger than the external diameter of the cylindrical member. A tapered split ring within the internally tapered ring has an outside taper complementary to the inside taper of said first mentioned ring and has inwardly extended teeth, circumferentially disposed on its inner surface, and a longtitudinal slot. The first mentioned ring bears against the connector body and the split ring against the shoulder formed by the capped part of the cap nut and is forced under compression into the first mentioned ring on screwing movement of the nut on to the connector body to clamp around the cylindrical member inserted therein.

No special tools are required to secure the connector to a rod or tube; in most cases only a small wrench will be required. Furthermore, in applying connectors according to the present invention, no care need be taken to apply exactly the right force in tightening the connector. The connector is designed so that it virtually cannot be tightened past the desired point. The connectors of this invention may be tightened by hand, for example as a pre-assembly convenience, and when so tightened they are comparable in performance to conventional fittings.

A particular type of connector as shown in the drawings is adapted for use with radio frequency coaxial cable of the semi-flexible type. This connector is shown with this type of cable for the purpose of illustration because connections involving that type cable are relatively complicated compared with other types and thus many advantageous features of the invention are illustrated. It should be appreciated, however, that connectors according to the present invention may be adapted for use in the connection of rods or tubes of any type whatsoever. Thus they may be utilized in plumbing installations for connecting copper or brass pipes, or they may be utilized in building, mechanical, or other arts for the connection of structural steel rods. Obviously the connectors may also be utilized for connection of electrical cables other than the radio frequency or coaxial cable shown by way of illustration.

The advantages of the present invention will be apparent from a consideration of the following description in conjunction with the appended drawings, in which:

Figure 1 is a side elevational view of a connector according to the present invention;

Figure 2 is a vertical sectional view of the connector of Figure 1, together with a tube and other connecting elements;

Figure 3 is an exploded view of the elements of the apparatus of Figure 2.

Referring now to the drawings, Figure 1 shows a connector 11 according to the present invention. Connector 11 has a body portion 12 which has an enlarged portion 13 of

hexagonal external configuration so that it may readily be gripped by a wrench or similar tool, or may be turned by hand.

A compression nut 14 is threaded on the end of the connector body 12 and operates to secure a tube or rod within the connector, as will later be explained. The connector body 12 is also provided with a flange 15 which serves to secure the connector 11 to another connector or other structure.

Figure 2 shows the connector 11 in greater detail and also shows the manner in which it may be utilized to provide a fitting for a particular type of electrical cable. In Figure 2 the connector 11 is shown adapted to connect a length of radio frequency coaxial cable to a standard connector for this type of cable. It should be understood that connectors according to the present invention may be utilized to provide a widely diverse assortment of connector structures, including connectors for solid structural rods or fluid conduits as well as connectors for various types of electrical cable. The cable 17 is provided with a jacket 18 formed of aluminum and has a center conductor 19 formed of copper which is supported centrally within the aluminum jacket 18.

If a section of cable 17 is to be prepared for a connector 11, it is only necessary that the end of the outer aluminum jacket 18 be removed for a suitable length as indicated in the drawings and that the supporting structure for the center conductor 19 be removed for a similar distance. Thereafter, any rough edges on the center conductor 19 or on the end of the cable jacket 18 may be smoothed off to facilitate assembly of the connector on the cable end. The cable 17 in Figure 2 is shown prepared for attachment of the connector 11. A center conductor fitting 21 is provided which has a male connector portion 22 and a female connector portion 23. The female connector portion 23 is made in the form of a sleeve and fits over the center conductor 19. An insulator ring 24 is attached to the central portion of the center conductor fitting 21 and supports and insulates the fitting 21 from the connector body 12. The insulating ring 24 may be formed of any suitable insulating material, such as polyethylene, tetrafluoroethylene, nylon, or the like.

An access port 25 is provided in the body 12 of the connector 11. An access plug 26 is screwed into a threaded portion of the access port 25 to provide a closure. In the illustrated embodiment of the invention the access port 25 allows sections of the cable 17 to be purged of moisture and other contamination and to be filled with dry air or nitrogen and pressurized, or evacuated, if desired. Obviously the access port 25 and the plug 26 may be eliminated for connector applications where they are unnecessary.

The flange 15 is provided with a number of holes, one of which is shown at 27. The flange 15 may thus readily be bolted to another connector or any other structure to which it is desired to secure the cable 17. Although the connector arrangement of Figure 2 is designed to provide a particular type of standard coaxial cable connector utilized by the military services, it is obvious that the connector may be assigned to connect the cable 17 to any desired type of structure or fitting.

A particular advantage of a connector 11 shown in Figure 2 resides in the fact that the flange 15 is not immovably secured to the body 12 but is rotatably affixed thereto. This provides an obvious advantage in securing the connector 11 to another structure in that the holes 27 in the flange 15 may readily be aligned with holes in the structure to which it is to be connected.

The rotatable attachment of the flange 15 to the body 12 is provided by grooves 28 and 29 in the flange 15 and body 12, respectively. A split ring 31 of steel, aluminum or other material is placed within the grooves 28 and 29 in such a way that longitudinal movement

of the flange 15 with respect to the body 12 is prevented while rotational movement of the flange 15 is permitted.

The flange 15 may be assembled on the body 12 by placing the ring 31 in the groove 28 and expanding it so that it will fit over the body 12 and thereafter allowing the ring 31 to contract and seat itself in the groove 29. Although the rotatable flange 15 is a very useful feature of the connector 11, it is obvious that the connector 11 may be provided with an integral flange or, in many cases, an entirely different arrangement may be desired to secure the connector 11 to particular types of elements or structures.

A novel feature of major importance in the present invention is the means provided for securing the cable 17 to the connector 11. The compression nut 14 forming a part of this means is provided with threads 33 which co-operate with threads 32 on the body 12 of the connector and allow the nut 14 to be threaded onto the connector body 12.

The compression nut 14 is provided with a portion of enlarged internal diameter as shown at 34, in which are located a tapered ring 35 and a split tapered ring 38.

The tapered ring 35 abuts against the end of the connector body 12 where there is located an O-ring 36 placed in an O-ring seat at 40. The O-ring preferably has an internal diameter equal to or greater than the external diameter of the jacket 18, thereby facilitating ready and easy pre-assembly while the O-ring is in place. The tapered ring 35 deforms the O-ring 36 and causes it to be forced against the jacket 18 of the cable 17 to form a fluid type seal between the cable 17 and the connector 11. In some cases the O-ring 36 may be omitted; in particular where the connector is utilized in an application where it is not necessary to provide a fluid-tight seal. Even where a fluid-tight seal is desired, it will be noted that the jacket 18 of the cable 17 abuts against the shoulder 43 in the body 12 of the connector 11 and provides a fluid seal independent of O-ring 36. As will later be explained, the jacket 18 is pressed against the shoulder 43 with substantial force, and usually this force will be sufficient to provide a fluid-tight seal at the shoulder 43. Therefore the O-ring 36 need be used only where an abundance of precaution is desired.

The tapered ring 35 is provided with external threads 37 along a portion thereof. These threads prevent the tapered ring 35 and the split tapered ring 38 from accidentally falling out of the compression nut 14 even when the compression nut 14 is completely removed from the conductor body 12. When desired, however, the tapered ring 35 may be removed from the compression nut 14 by threading it past the threads 33. At this time the split taper ring 38 may also be removed. The threads 37 therefore provide an effective means for preventing loss of the rings 35 and 38 without materially adding to the cost of fabrication of the connector assembly.

The actual gripping of the cable 17 by the connector 11 is provided by annular interior sawteeth or shearing edges 39 within the split ring 38. The split ring 38 is cut at 42 (shown in Figure 3), so that the ring 38 may be contracted to cause the teeth 39 to bite into the jacket 18 of the cable 17. The teeth 39 are forced into the jacket 18 due to the action of the compression nut 14 which has a shoulder 41 which bears against the end of the split ring 38, and upon turning of the nut 14, drives the split externally tapered ring 38 into the correspondingly internally tapered ring 35 causing the teeth 39 to cut into the jacket 18. This sidewise movement of the nut assembly simultaneously forces the jacket 18 laterally, so that the end of the jacket 18 is forced firmly against the shoulder 43 inside the connector body 12. The internal surface of the shoulder 41 and the surface of the split tapered ring 38 against which it bears are preferably smooth and rounded, so that there is a minimum of friction encountered as the shoulder 41 rotates against the split tapered ring 38.

It should be noted that once the split tapered ring 38 is forced into the tapered ring 35, there is no relative rotational movement therebetween. This is due first to the fact that the area of surface contact, and hence of frictional engagement, between the rings 35 and 38 is much greater than the area of surface contact between the ring 38 and the shoulder 41. Secondly, as soon as the split tapered ring 38 begins to cut into the jacket 18 the cut 42 narrows in width and forms a ridge of material from the jacket 18 which thereafter further prevents rotational movement of the split tapered ring 38. The elimination of rotational movement between the two tapers is important due to the fact that successful operation of the connector requires freedom of sliding movement of the split tapered ring 38 within the tapered ring 35, and if substantial rotational movement is imparted, these rings will tend to seize and proper operation of the connector will be prevented.

It should be appreciated that a principal advantage of the present invention is that the amount of shearing cut made by the teeth 39 in the jacket 18 is not left to chance but is under close control to provide an eminently strong connection between the connector 11 and the jacket 18 and at the same time avoding undue weakening of the jacket wall. As the nut 14 is tightened on the connector body 12, the split tapered ring 38 is forced axially into the tapered ring 35. As this takes the place the split tapered ring 38 is contracted until it begins to shear and bite into the jacket 18 of the cable 17 at some predetermined point. In Figure 2 the rings 38 and 35 are shown at a point just before the split tapered ring 38 begins to shear and bite into the jacket 18 of the cable 17. As the nut 14 is tightened further, the teeth 39 in the ring 38 will continue to bite and shear into the jacket until the ring 38 is forced completely into the ring 35, at which point no further compression of the ring 38, and hence no further cutting of the teeth 39 is possible.

It is to be noted that the shearing edge of the teeth preferably is designed so that a true shearing action occurs. The rake of each tooth is preferably perpendicular to the axis of its travel during the assembly. The tooth relief is preferably relatively shallow and provides adequate support for the shearing edge. As the shearing edges advance upon tightening the assembly, a square shoulder and wave of material of the jacket 18 is established ahead of each tooth or shearing edge, thus further enhancing the locking action of the assembly.

It is readily possible to determine exactly where the teeth 39 will start to bite into the jacket since the dimension of the jacket 18 is known and the dimensions of the rings 35 and 38 are also known. This point where the teeth 39 first begin to bite is determined, so that the total distance traveled by the ring 38 during the biting or cutting of the teeth is less than the pitch of the teeth (the longitudinal distance between adjacent teeth.) This is an important consideration since this construction prevents any one of the teeth cutting into the tube at a point already scored by a previous tooth. If one of the teeth should pass over a point previously scored by foregoing teeth, the depth of cut of that particular tooth and hence the strength of grip of the split ring 38 would be diminished. Furthermore, when succeeding teeth pass over a portion of the jacket already cut by previous teeth the cross-sectional area of the jacket wall is diminished and the strength of the jacket is decreased without any increase in the strength of the connector grip.

In addition to complete control of the length of cut of the teeth 39 the connector 11 provides complete control of the depth of cut of the teeth 39 in a tube or rod of known diameter. The depth of cut of the teeth 39 is not affected by the amount of force used to tighten the nut 14, but is rather determined in advance and results when the nut 14 is tightened to stop at the point where ring 38 is forced completely into ring 35 when ring 35 has an axial length at least as great as ring 38. When desired, however, ring 38 may be axially longer

than ring 35, but the former relationship is preferred. When ring 38 is not longer than ring 35, and axial pressure is not applied to the assembly of the rings one inside the other, the springiness inherent in ring 35 exerts a constant tendency to cause ring 35 to tend to pop out of ring 38, facilitating disengagement of the assembly. Since the connector 11 allows the depth of cut of the teeth 39 to be subject to close control, the depth of cut can be determined to provide a maximum of gripping strength of connector 11 relative to the cable 17, and also, the weakening of the cable 17 due to the cutting action of the teeth can be held to a minimum.

This is best demonstrated by a specific example. Each tooth 39 has a substantially vertical wall and an oblique wall. The vertical wall is substantially perpendicular to the axis of the split ring 38. Assume that the wall of the jacket 18 is .070 inches thick. The cut of the teeth 39 may then be predetermined by design of the rings 35 and 38 to be .010 inches. In such a case each of the seven teeth 39 cuts into the jacket 18 to a depth equal to one-seventh of the jacket thickness and thereby provides a gripping action equal to one-seventh of the total original strength of the cable jacket 18. Thus the total gripping action of the seven teeth 39 is equal to the original cable jacket strength. At the same time the thickness of the jacket wall at its weakest point will have been reduced by a factor of only one-seventh or less than 15 per cent. Therefore the connector 11 grip the cable 17 with a gripping strength greater than the final strength of the cable jacket 17, and the strength of the weakest portion of the connection, namely the weakened portion of the cable 17 is still within 15 per cent of the original strength of the cable itself. It will be particularly appreciated that exceptional strength is provided by the present connector when it is considered that many connectors of similar type produce a connection having a strength of only 50 per cent or less than that of the tubing being connected, and the tubing is often weakened by an equal amount.

From the foregoing explanation, it will be understood that the electrical connector 11 shown in Figures 1, 2 and 3, provides a connection which is fluid-tight and furthermore may have a strength very nearly equal to or greater than that of the cable wall being connected. Furthermore, the connector provides an electrical structure which has very low D. C. resistance at all frequencies which are substantially the same as that of the cable 17 itself, and virtually no mechanical or dimensional irregularities are produced by the connector of this invention to interfere with the propagation of radio frequency energy through the cable 17 and connector 11.

Another advantage of the invention resides in ready and easy disassembly. Where the nut 14 is unscrewed or released, even after wrench-tight assembly, the cable may be disengaged by simply tapping the assembly. Loosening the nut 14 releases the ring 35 for longitudinal movement. The inherent resilience of springiness of the compressed split ring 38, pressed in sliding relation within its tapered confinement, causes it to slide or pop out of the rigid ring 35.

It is obvious that many of the features of the particular connector shown may be eliminated where a connector is desired for other applications. As an example, it may in some cases be desired to connect an eye bolt to a tie rod. In such a case the many features of the connector body 12 which are useful in a radio frequency cable connector could be eliminated, and the connector body 12 may consist simply of an eye bolt structure having threads similar to 32 adapted to co-operate with the threads 33 of the compression nut 14. In this application the cable 17 would be replaced by a tie rod which might either be hollow or solid and which could be formed of any structural material such as iron, steel, aluminum or the like. Generally it will be desirable to form the connector of the same material or of a similar material to that of the rod or tube being connected. Thus a steel or stainless steel connector could be utilized for steel rods, an aluminum connector for aluminum rods, etc.

Another application for connectors according to the present invention is in the field of fluid conduits. In this application, as in the structural connector application, the features useful in the radio frequency electrical connector will generally not be required. On the other hand, for connecting copper water pipe it might be desirable to provide a connector similar to that shown in Figs. 1 and 2, except with the left end formed in a manner similar to the right end as shown in Figs. 1 and 2, so that the connector could be utilized for connecting two similar pieces of copper tubing. Similarly, a connector may be provided for connecting one size of tubing to another. Also, a connector according to the present invention may be included as a part of a plumbing fixture so that copper tubing may be connected directly to the fixture without the necessity of soldering or other time consuming operations. Obviously many other forms of connectors may be devised utilizing the principles of the connector shown and of the present invention.

From the foregoing explanation it will be appreciated that the present invention provides connectors of great simplicity and efficiency which are adaptable for use in numerous widely divergent types of applications. Although certain variations and modifications have been suggested hereinbefore, many further variations will be obvious to those having a knowledge of various arts in which connectors are utilized, and accordingly, the present invention is not to be construed to be limited to the particular embodiments of the invention shown or suggested. Rather, the invention is to be considered to be limited solely by the appended claims.

The claims defining the invention are as follows:

1. A connector assembly for releasably connecting a cylindrical member with a connector body in intimate contact, said connector body having a hollow externally threaded end portion and a cap nut having a threaded part screwable thereon, the cap part of said nut having an aperture permitting free movement therethrough of said cylindrical member, an internally tapered ring within an enlarged internal portion of said cap between said cap part and said threaded part, the smallest internal diameter of said ring being slightly larger then the external diameter of said cylindrical member, a tapered split ring within the internal tapered ring having an outside taper complementary to the inside taper of said first ring and having inwardly extending teeth circumferentially disposed on its inner surface and a longitudinal slot in said tapered split ring, said first ring bearing against said connector body, and said split ring bearing against a shoulder formed by the cap part of said cap nut and being forced under compression into said first ring on screwing movement of said nut onto said connector body to clamp around the cylindrical member inserted therein. (2nd June, 1958).

2. A connector assembly according to claim 1 in which the longitudinal movement of said split ring is limited by the shoulder of said cap nut abutting against said tapered ring, said split ring being so dimensioned that the distance between the point of engagement of each tooth with the cylindrical member and the position of each tooth at the completion of the longitudinal movement of the split ring is not more than the pitch of said teeth. (2nd June, 1958).

3. A connector assembly according to claim 1 or 2 in which said tapered ring has an outside thread cooperating with thread in said cap nut to retain said ring in said nut on removal of said nut from said connector body. (2nd June, 1958).

4. A connector assembly according to any one of the preceding claims in which the surfaces of the circumferentially disposed teeth of the split ring face away from the connector body and the surfaces of said teeth facing towards said connector body are substantially perpendicular to the axis of said split ring. (2nd June, 1958).

5. A connector assembly according to any one of the preceding claims in which said split ring is resilient. (2nd June, 1958).

6. A connector assembly substantially as shown and described. (2nd June, 1958).

ARTHUR S. CAVE.
Patent Attorney for Applicant.

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